MISR Highlights from the First 18 Months in Earth Orbit

David J. Diner and the MISR Science Team
c/o Jet Propulsion Laboratory, California Institute of Technology
Mail Stop 169-237
4800 Oak Grove Drive
Pasadena, CA 91109 USA
T: 818.354.6319 F: 818.393.4619 EMail: David.J.Diner@jpl.nasa.gov

***Abstract* -- The Multi-angle Imaging SpectroRadiometer (MISR) instrument was launched into polar orbit aboard the Terra spacecraft in December 1999. MISR provides a unique approach to characterizing atmospheric aerosols, the surface, and clouds. This paper provides examples of MISR products and highlights results derived from imagery acquired during the first 18 months of the Terra mission.**

INTRODUCTION

MISR [1] began collecting Earth imagery in February 2000. The instrument uses nine separate charge coupled device (CCD)-based pushbroom cameras to observe the Earth at nine discrete angles: one at nadir, plus eight other symmetrically placed cameras that provide fore-aft observations with view angles, at the Earth's surface, of 26.1, 45.6, 60.0, and 70.5º relative to the local vertical. Imagery in four spectral bands (446, 558, 672, 866 nm) is provided at each angle, yielding a total of 36 image channels (9 angles x 4 bands). Spatial sampling ranging from 275 m to 1.1 km is obtained over a 400-km swath.

MISR's remote sensing capabilities include retrieval of aerosol properties over many surface types; stereoscopic retrieval of cloud-top heights and cloud-tracked winds; and determination of surface and cloud spectral albedos and characterization of their architecture through the use of angular signature information. Data products from MISR are generated and archived at the NASA Langley Atmospheric Sciences Data Center *(http://eosweb.larc.nasa.gov)*.

EXAMPLE APPLICATIONS

Remote sensing of aerosol optical depth over land is a difficult challenge owing to the variable brightness of the land surface. However, multi-angle imagery provides the opportunity to use the variation in signal with angle to detect and characterize atmospheric hazes. An example is shown in Figure 1. The image on the left is a nadir view of the Bitterroot Mountains near the Montana-Idaho border from August 14, 2000, when intense wildfires were devastating much of this area. The middle image was acquired by the 70.5º-forward-viewing camera. Note how the increased slant path through the atmosphere accentuates the appearance of smoke plumes relative to the nadir view. The right-hand panel shows retrieved optical depth, using an algorithm that uses angular signatures to separate the surface and atmosphere leaving signals [2].

In addition to utilizing the radiometric variation of signal with angle, stereophotogrammetric methods using a combination of area and feature matching algorithms are applied to measure the geometric parallax due to cloud height, plus actual motion driven by wind. The cloud motion capability results from the 7-minute time interval within which the nine multi-angle views of a given scene are acquired [3]. Figure 2 shows cloud motion vectors derived from MISR imagery superimposed upon nadir images of a vortex street near Guadalupe Island (June 11, 2000) and Hurricane Debby (August 21, 2000).

Other examples highlighting MISR's capabilities will be discussed during the presentation.

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REFERENCES

[1] D.J. Diner, J. Beckert, T. Reilly, C. Bruegge, J. Conel, R. Kahn, J. Martonchik, T. Ackerman, R. Davies, S. Gerstl, H. Gordon, J-P. Muller, R. Myneni, P. Sellers, B. Pinty, and M. Verstraete, "Multi-angle Imaging SpectroRadiometer (MISR) instrument description and experiment overview," *IEEE Trans. Geosci. Rem. Sens.* **36**, pp. 1072-1087, 1998.

[2] Martonchik, J.V., D.J. Diner, R.A. Kahn, T.P. Ackerman, M.M. Verstraete, B. Pinty, and H.R. Gordon, "Techniques for the retrieval of aerosol properties over land and ocean using multiangle imaging," *IEEE Trans. Geosci. Rem. Sens.* **36**, pp. 1212-1227, 1998.

[3] Horvath, A. and R. Davies, "Feasibility and error analysis of cloud motion wind extraction from near simultaneous multiangle MISR measurements," *J. Atmos. Oceanic Tech.* **18**, pp. 591-608, 2001.

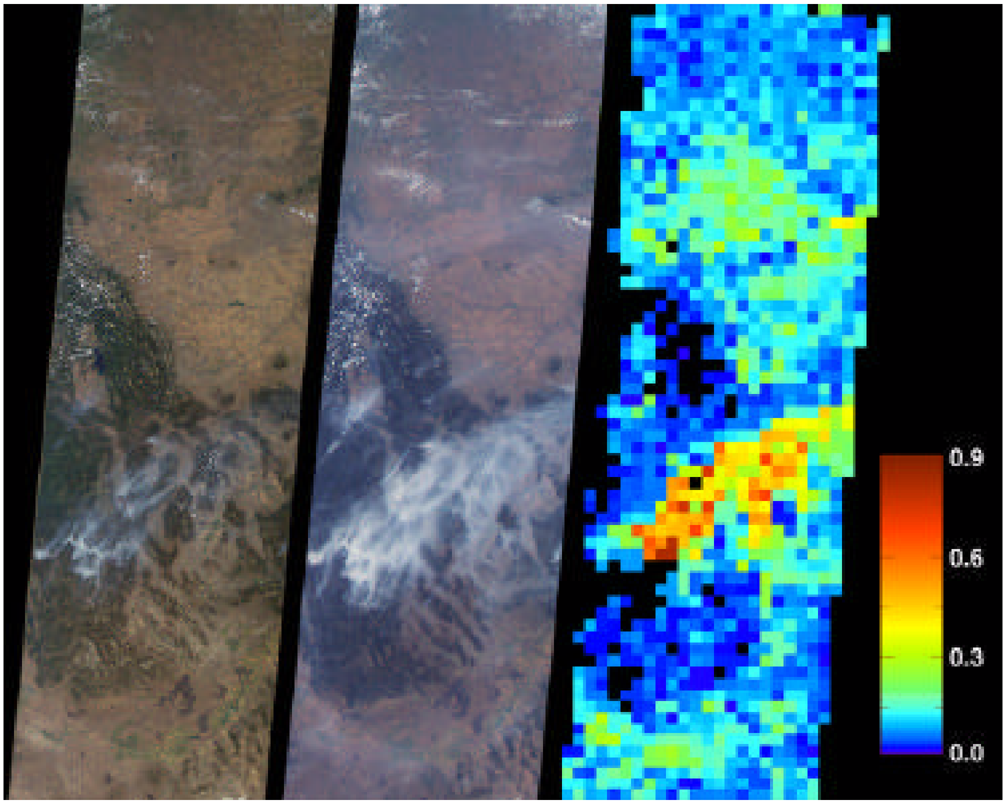

Figure 1. (Left) MISR nadir view of the Bitterroot Mountains near the Montana-Idaho border from August 14, 2000. (Middle) 70.5º-forward view. (Right) Retrieved aerosol optical depth at 558 nm. Areas where no retrievals were obtained are shown as black. Retrievals are performed over 17.6 x 17.6 km^2 regions, and thus have coarser resolution than the underlying imagery.

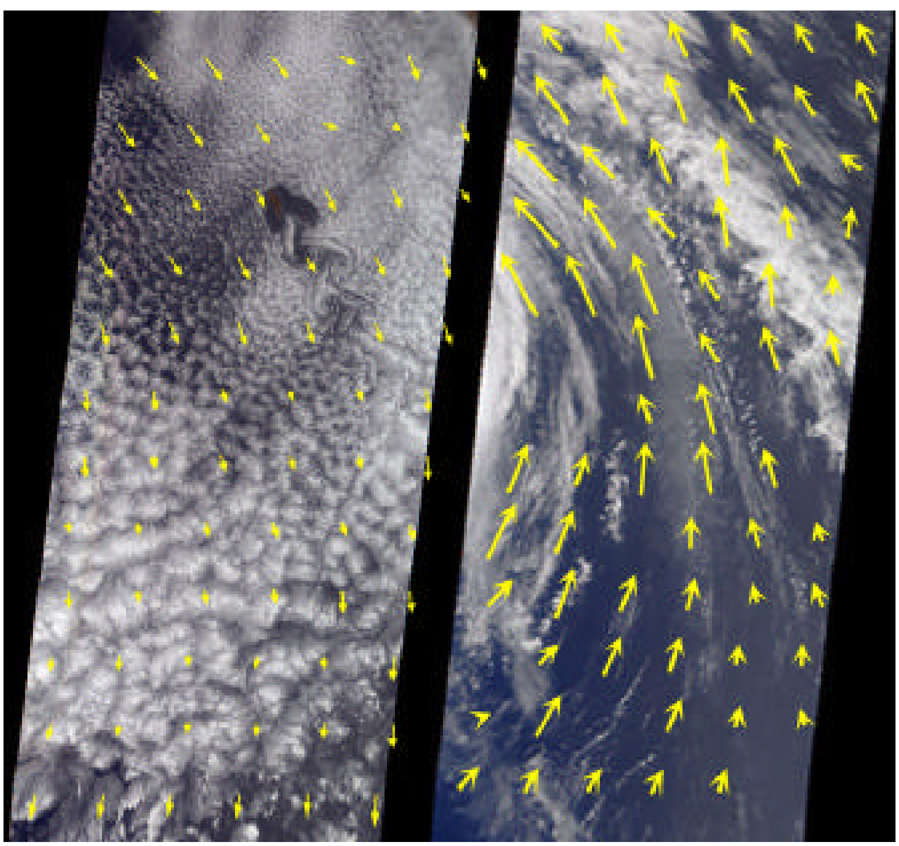

Figure 2. (Left) MISR nadir view of a von Karman vortex street downwind of Guadalupe Island, Mexico in the Pacific Ocean, from June 11, 2000. The island is located in the clear area near the upper center of the image, and forms an obstacle to the prevailing wind. The marine stratocumulus clouds make the induced turbulent flow visible, and enable retrieval of the winds. Retrieved wind vectors are superimposed; typical values are ~ 6 m sec^{-1}. Note how the local wind vectors align with the vortex street. Wind vectors are derived over 70.4 x 70.4 km^2 domains. (Right) Similar view with superimposed wind vectors, in this case of Hurricane Debby in the Atlantic Ocean from August 21, 2000. Here, the largest wind speeds are ~ 25 m sec^{-1}.